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10/532816
JC12 Rec'd PCT/PTC 26 APR 2005

AIR COOLING DRY VACUUM PUMP

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to an air cooling dry vacuum pump applied to medical instruments, food instruments, electric machines, electronic instruments, optical instruments, packaging machines, machines using a semiconductor and the like, which has an excellent heat exchangeability and is capable of discharging clean exhaust gases, allowing an installation space to be reduced due to a small and compact size, and reduced in weight and noise.

Description of the Related Art

Generally, a vacuum pump is driven in condition that high sealing level is maintained by closing inlet side for fluid thereof. Thereby, rotating force of a motor is mostly exchanged to heat. In this case, the generated heat has a large calorific value, so that when no countermeasure is taken, the vacuum pump is damaged by burning because of the heat and cannot be driven continuously.

The vacuum pump is driven in vacuum condition so that, if a compression ratio of a compressible fluid becomes high, a driving force of the motor for driving the vacuum pump is exchanged to heat generating large calorification. Therefore, there generally is a wet-type vacuum pump, which is cooled by pouring oil or water in a duct at an inlet side of the vacuum

pump. The vacuum pump has possibly trouble that the water or oil for cooling does not flow toward an outlet side of the vacuum pump, but flows oppositely toward a chamber side to be vacuumed connected to the inlet side of the vacuum pump and vacuum condition thereof is failed. Instead of the wet-type vacuum pump, a dry vacuum pump attracts notice in a point of view of protecting/maintaining terrestrial environment, preventing contamination by toxic chemical materials and improving super-precision processing and accuracy thereof.

For taking a countermeasure for that the vacuum pump is damaged by burning because of calorification, the dry vacuum pump is a fluid-cooling vacuum pump that includes a jacket at a casing of the vacuum pump. By flowing coolant through the jacket, the calorification is cooled to make a thermal balance. It is shown in a Patent Reference of Japan Patent Application Laid Open No. H7-167091.

The fluid-cooling vacuum pump uses coolant such as pure water or industrial water, so that instruments or apparatuses such as pipes and pumps for transmitting the coolant are required. Processing system for treating coolant as waste water is also required. If recycling the coolant for reuse, a cooling system and a anti-corrosive process system are required. Many instruments for building these systems are required so that there are many difficulties such as a huge cost.

However, fluid-cooling vacuum pump uses coolant such as pure water or industrial water, so that instruments or

apparatuses such as pipes and pumps for transmitting the coolant are required. Processing system for treating coolant as waste water is also required. If recycling the coolant for reuse, a cooling system and a anti-corrosive process system are required. Many instruments for building these systems are required so that there are many difficulties such as a huge cost.

The inventor invented the present invention by focusing the air cooling vacuum pump for cooling calorification of a heated area of the vacuum pump instead of the above water-cooled vacuum pump after long years of research and development about it and effort about it.

An object of this invention is to provide an air cooling dry vacuum pump which has an excellent heat exchangeability and is capable of discharging clean exhaust gases, allowing an installation space to be reduced due to a small and compact size, and reduced in weight, noise, manufacturing cost, and equipment cost, differing from a simple air cooling dry vacuum pump for cooling by increasing area of heat radiation for cooling by providing fins at an outside of the heat portion of the vacuum pump.

Summary of the Invention

In order to attain the object, an invention described in claim 1 is a vacuum pump placing rotors to be rotated by receiving a driving force of a motor as a driving source of rotation in a casing having an inlet for fluid and an outlet for the fluid, which is characterised in that the casing is provided at one

end in an axial direction of the casing with air supplying means, and the casing is formed into a duplex tube structure with an inner tube and an outer tube provided around the inner tube, and an air duct, through which cooling air supplied by the air supplying means flows, is provided along the axial direction between the inner tube and the outer tube.

An invention described in claim 2 is a vacuum pump according to claim 1, which is characterised in that the air duct is provided along the axial direction corresponding to a heat generating member including the motor as the driving source of rotation, rotational force transmission parts such as a rotating speed up gear for transmission of a driving force from the motor to the rotor, a timing gear and the like, a roller bearing supporting rotatably a shaft of the rotor, and rotors engaging with each other, and heat generated from the heat generating member flows conventionally with cooling air flowing through the air duct by the air supplying means for heat exchange.

An invention described in claim 3 is a vacuum pump according to claim 1 or 2, which is characterised in that the air supplying means is a ventilation fan or a suction fan.

An invention described in claim 4 is a vacuum pump according to claim 1, 2 or 3, which is characterised in that the casing for receiving the rotors, a rotating speed up gear section for receiving the rotating speed up gear as the rotational force transmission parts, and a timing gear section for receiving the

timing gear assembly the air duct cooperatively by being connected through a connecting member between the inner tube and the outer tube of the duplex tube structure.

An invention described in claim 5 is a vacuum pump according to claim 1, 2, 3 or 4, which is characterised in that the rotating speed up gear section and the timing gear section are constructed into upper/lower two sections separated by a partition wall, and the two sections are communicated through a duct with each other so as to be capable of circulating lubrication oil by convection.

An invention described in claim 6 is a vacuum pump according to claim 1, 2, 3, 4 or 5, which is characterised in that the rotor is mounted on a rotor shaft, one end of which is rotatably supported by a first roller bearing placed at the timing gear section fixed on one side of the casing.

An invention described in claim 7 is a vacuum pump according to claim 1, 2, 3, 4, 5 or 6, which is characterised in that the rotor is mounted on the rotor shaft so as to approach to an other side of the casing, which is provided with the inlet and sealed, and the other end of the rotor shaft is supported rotatably by a second roller bearing placed at a support cylinder with a small diameter, which is fixed on the one side of the casing.

An invention described in claim 8 is a vacuum pump according to claim 1, 2, 3, 4, 5, 6 or 7, which is characterised in that an outer wall of at least one of the casing, the motor and the air supplying means is covered with a sound absorbing material

in accordance with requirement.

According to the present invention, an air cooling dry vacuum pump has an excellent heat exchangeability and is capable of discharging clean exhaust gases, allowing an installation space to be reduced due to a small and compact size, and reduced in weight, noise, manufacturing cost, and equipment cost.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view of the first embodiment of an air cooling dry vacuum pump according to the present invention;

Fig. 2 is a perspective view of the air cooling dry vacuum pump shown in Fig. 1;

Fig. 3 is a front view of the air cooling dry vacuum pump shown in Fig. 1;

Fig. 4 is a plan view of the air cooling dry vacuum pump shown in Fig. 1;

Fig. 5 is a bottom view of the air cooling dry vacuum pump shown in Fig. 1;

DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment 1 of the present invention will be described with reference to figures.

FIRST EMBODIMENT

Fig. 1 is a vertical cross-sectional view of the embodiment 1 of an air cooling dry vacuum pump according to the present invention. Fig. 2 is a perspective view of the air cooling dry vacuum pump. Fig. 3 is a front view of the air cooling dry vacuum

pump. Fig. 4 is a plan view of the air cooling dry vacuum pump. Fig. 5 is a bottom view of the air cooling dry vacuum pump.

The dry vacuum pump according to the embodiment 1 has a structure and functions as same as a vacuum pump by prior art described in the patent reference 1 with respect to placing a rotor 2 to be rotated by receiving a driving force of a motor M as a driving source of rotation into a casing 1 having an inlet 1a of a fluid G and an outlet 1b of the fluid.

In the embodiment 1, an air supply fan 3 as an air supplying means is provided at one side in an axial direction I of the casing 1. The casing 1 is formed into a duplex tube structure with an inner tube 4 receiving the rotor 2 rotatably and an outer tube 5 provided around the inner tube 4. The embodiment shown in figures is a two-axes axial-flow type vacuum pump including two rotors 2A, 2B to be received in two inner tubes 4, 4, which are provided symmetrically about a radial direction Q of the casing 1 as shown in Fig. 4.

The two rotors are formed at outer wall thereof with respective screws having deferent helix direction from each other. For example, if one rotor 2A is a right hand screw, the other rotor 2B is a left hand screw. The screws with deferent helix directions of the rotors 2A, 2B are formed with a large pitch 6a and a pitch 6b smaller than the large pitch 6a from an inlet side toward an outlet side of the vacuum pump. Sucked gas is compressed by the pitches 6a, 6b.

Air ducts 7, 7 are provided between the inner tubes 4, 4

and the outer tubes 5, 5 along the axial direction I of the casing 1 to flow cooling air W from the air supply fan 3 therethrough.

The air duct 7 is provided vertically along the axial direction I corresponding to a heat generating member including the motor M as the driving source of rotation, rotational force transmission parts 10 such as a rotating speed up gear 8 transmitting a driving force from the motor M to the rotor 2A, timing gears 9A, 9B and the like, roller bearings 12A, 12B; 12A, 12C supporting rotatably shafts 11A, 11B of the rotors 2A, 2B, and rotors 2A, 2B engaged with each other. In Fig. 4, the two rotors 2A, 2B are provided into a ellipse shape in plan view corresponding to the two-axes axial-flow type vacuum pump. The shape in plan view is a typical example, and a suitable shape not limited in the shape can be applied and number of rotors can be increased or decreased freely.

The casing 1 receiving rotors 2A, 2B and a rotating speed up gear section 13 receiving the rotating speed up gear 8 as the rotational force transmission parts 10 and a timing gear section 14 receiving the timing gears 9A, 9B structure cooperatively the air ducts 7, 7 integrally by being connected through a connecting member between the inner tube 4 and the outer tube 5 of the duplex tube structure.

Heat generated from the heat generating member flows conventionally with cooling air W from the air supply fan 3 flowing through the air ducts 7, 7 for heat exchange.

The rotating speed up gear section 13 and the timing gear

section 14 are structured with upper/lower two sections separated by a partition wall. The two sections are communicated through a duct 15A provided at a center of the inner wall and a duct 15B provided at an outer side with each other so as to be capable to circulate lubrication oil O by convection. The duct 15A provided at the center of the inner wall is formed into a short pipe and induces convention of the lubrication oil O.

The rotors 2A, 2B are mounted with mechanical lock members m, m on rotor shafts 11A, 11B as a main shaft and a countershaft, which one ends 16a are rotatably supported by first roller bearings 12A, 12A placed at the timing gear section 13 fixed on one side 1c of the casing 1.

Since the rotors 2A, 2B are mounted on the rotor shafts 11A, 11B to approach to the other side 1d of the casing 1, which is a sealing wall other than the inlet 1a, gas tightness at the inlet can be performed.

The other ends 16b of the rotor shafts 11A, 11B are supported rotatably by second roller bearings 12B, 12B placed at support cylinders 17 with a small diameter, which is fixed on the one side 1c of the casing 1. Ball bearings are used for these roller bearings 12A, 12A; 12B, 12B as shown in Fig. 1. Roller bearings can be used also.

When low sound noise is required, a sound absorbing material 18 is provided in accordance with requirement, but is not necessarily provided. The sound absorbing material 18 covers an outer wall of at least one of the casing 1, the motor M and

the air supply fan 3. In the embodiment 1, the sound absorbing material 18 covers all of them as shown in Fig. 1.

Porous material having high sound absorbing property, such as polyurethane foam, sponge rubber, felt, non-woven fabric, laminated cloth by synthetic resin fiber or natural fiber, and the like, is used for the sound absorbing material 18.

A fin 19 is formed at an outer wall of the outer tube 5 of the casing 1 for radiating heat.

Plurality of hoist hooks 20 is mounted on a top surface of the casing 1 for moving the pump easily by a hoisting machine like a crane by hooking a wire thereon when moving or storing it.

A level gage is 21 and an air breather is 22.

The embodiment 1 of the present invention is structured as mentioned above. When the motor M drives, the rotor shafts 11A, 11B rotate by receiving a rotating force from the motor M through the rotational force transmission parts 10 of the rotating speed up gear 8 and timing gears 9A, 9B engaged with each other. The rotors 2A, 2B, which have the screws having deferent helix directions are provided on the outer walls thereof, mounted on the rotor shafts 11A, 11B are rotated in deferent rotating directions from each other in the inner tubes 4, 4 provided in the casing 1 so as to engage the large pitch 6a and the small pitch 6b. When the motor M drives, a fan motor drives simultaneously so that the air supply fan 3 as the sir supplying means is rotated.

Gas as fluid is sucked from the inlet 1a provided at the other end 1d (as a top surface in Fig. 1) and led into the inner tube 4 of the casing 1. The gas is led from the rotor 2A at a primary side to the rotor 2B at a secondary side, the both rotors 2A, 2B rotating to engage the large pitch 6a and the small pitch 6b, and compressed adiabatically toward a downstream side. The gas is discharged from the outlet 1b provided at the side wall of the casing 1.

At the time, the heat generating member, which includes the motor M as the driving source of rotation, rotational force transmission parts 10 such as the rotating speed up gear 8 transmitting a driving force from the motor M to the rotor 2A, timing gears 9A, 9B and the like, roller bearings 12A, 12B; 12A, 12B supporting rotatably rotor shafts 11A, 11B of the rotors 2A, 2B, and rotors 2A, 2B rotating to be engaged with each other for compressing the gas, generates heat in accordance with driving the vacuum pump.

As mentioned above, when the air supply fan 3 starts to rotate, cooling air W is discharged through the air ducts 7, 7 provided between the inner tube 4 and the outer tube 5 vertically along the axial direction I in the casing 1 having the duplex tube structure with the inner tube 4 receiving the rotors 2A, 2B rotatably and the outer tube 5.

When the cooling air W rises through the air ducts 7, 7 with the duplex tube structure, the heat generated from the heat generating member is cooled through the air ducts 7, 7. Thus,

heat exchange is performed.

By convection (chimney effect) according to temperature rising of the air ducts 7, 7, cooling by the cooling air W supplied from the air supply fan 3 is effectively performed.

Furthermore, the motor M as the driving source of rotation for the rotors 2A, 2B of the vacuum pump, provided oppositely to the air supply fan 3 in a right/left direction under the casing 1 as shown in Fig. 1 can be cooled by the cooling air W supplied from the air supply fan 3.

The rotating speed up gear section 13 and the timing gear section 14 communicate through the duct 15A like a short pipe provided at the center of the inner wall and the duct 15B provided at an outer side. Thereby, the lubrication oil received in the rotating speed up gear section 13 and the timing gear section 14 is circulated by convection. Temperature rising of the lubrication oil corresponding to driving the vacuum pump is controlled and the lubrication oil is cooled. Furthermore, the rotating speed up gear 8, timing gears 9A, 9B engaged with each other, rotor shafts 11A, 11B and the like is lubricated and can be prevented from abrasion. The lubrication oil is pumped up by pressure generated by rotating the rotating speed up gear 8, so that convection between the rotating speed up gear section 13 and the timing gear section 14 is accelerated.

An outer wall of at least one of the casing 1, the motor M and the air supply fan 3 is covered with the sound absorbing material 18 in accordance with requirement. In the embodiment,

all walls of them are covered with the sound absorbing material 18. Sound noise generated by the motor M and the air supply fan 3 to be main sound noise source is absorbed by the sound absorbing material 8. Thereby, the sound noise is prevented from leakage to outside and the sound noise is reduced.

Even if the all walls of the casing 1, the motor M and the air supply fan 3 are covered by the sound absorbing material 18, since the heat generated from the heat generating member is exchanged by flowing the cooling air W from the air supply fan 3 through the air ducts 7, 7 provided between the inner tube 4 and the outer tube 5 vertically therethrough along the axial direction I in the casing 1, the heat exchange is performed smoothly and quickly with no obstacle by the sound absorbing material 18.

In the embodiment 1 shown in the figures, the cooling air W by the air supply fan 3 as the air supplying means is flown through the air ducts 7, 7 provided between the inner tube 4 and the outer tube 5 for exchanging the heat generated by the heat generating member. The present invention does not limit above. A suction fan, not shown, can be provided at the other end 1d of the casing 1 to communicate with the air ducts 7, 7 for sucking air in the air ducts 7, 7. Thereby, fresh air can be led from outside into the air ducts 7, 7 as the cooling air W. Thus, heat exchange of the heat generated from the heat generating member is within the aspect of the present invention.

In the embodiment 1 shown in the figures, the two-axes

axial-flow vacuum pump, which two rotors 2A, 2B engaged with each other are received rotatably in two inner tubes 4, 4, is shown as a typical vacuum pump. This is only an example, and the invention can be applied to single-axis axial-flow vacuum pump, which has one rotor and one inner tube 4 receiving the rotor therein. In the above embodiment, a vacuum pump for compressing gas as fluid G is described. It is an example, the invention can be applied to a pump for compressing liquid as fluid G.

INDUSTRIAL APPLICABILITY

According to the present invention, cooling air is supplied into a communicating duct having a duplex tube structure provided in a casing in the vicinity of a heat generating member, so that a vacuum pump has an excellent heat exchangeability. By supplying cooling air, apparatuses and materials, such as piping and a pump for transmitting cooling water, and a treatment system for waste water treatment are required. Furthermore, a cooling system for reusing coolant and a system for anti-corrosive treatment are not required so that clean exhaust gases can be discharged. Allowing an installation space to be reduced due to a small and compact size, and reduced in weight and noise, the vacuum pump can be applied suitably to medical instruments, food instruments, electric machines, electronic instruments, optical instruments, packaging machines, machines using a semiconductor and the like.